Abstract for an Invited Paper
for the DPP06 Meeting of
The American Physical Society

Electrostatic Collective Modes in a Pair Fullerene-Ion Plasma

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Pair plasmas consisting of electrons and positrons with an equal mass have experimentally been generated. However, the investigation of basic properties and collective modes in the positron-electron plasmas is very difficult because the annihilation time is short compared with the plasma period and the plasma density is low. Therefore our attention is concentrated on the stable generation of a pair-ion plasma consisting of positive and negative ions with an equal mass and the collective-mode investigation, where fullerenes are used as an ion source. When a hollow electron beam with 100 eV is injected into a fullerene vapor under a uniform magnetic field, positive ions are produced by electron impact ionization and electrons with low energy ($<$ 10 eV) are simultaneously produced. Negative ions are produced by electron attachment of these low-energy electrons. The electrons and the ions are radially separated by a magnetic-filtering effect. Only the positive and negative ions are expected to exist in the midmost of the hollow plasma, passing through an annular hole toward the downstream. The electron-free pair-ion plasma generation is attained here. Longitudinal-electrostatic modes propagating along the magnetic field lines are excited by a cylindrical/grid exciter, dispersion relations of which are investigated in detail. There appear three modes: an ion acoustic wave (IAW) and an ion plasma wave, both of which are predicted in the two-fluid theory, and an unprecedented intermediate-frequency wave which behaves like a backward wave. Furthermore, IAW is divided into two branches around the ion cyclotron frequency and another new backward wave appears, which joins the two branches together. The properties of the modes and the phase lag between the positive- and negative-ion density fluctuations will be discussed. The collaborator is W. Oohara.